THE PROGRESSIVE FISH CULTURIST

NEWS AND VIEWS FROM MANY SOURCES ON PRACTICAL HATCHERY PROBLEMS

ISSUED BY THE

BUREAU OF FISHERIES, U. S. DEPARTMENT OF COMMERCE

MARCH AND APRIL, 1937

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CONSERVATION PROGRESS BY THE BUREAU OF FISHERIES 1/

By Frank T. Bell, U. S. Commissioner of Fisheries.

TO THE THREE blind men of Calcutta in the old fable, the sacred elephant seemed to be a vine, a tree, or a smooth wall, according to whether in their groping efforts to obtain understanding they had grasped the tail, a leg, or a side of the animal. So the structure and functions of the Bureau of Fisheries are misunderstood by a majority of the people, few of whom come in contact with all of its many and varied activities. To the purse seine fisherman who invades closed waters in Alaska or to the dealers who ship black bass illegally, the Bureau is a stern officer of law enforcement. To the angler, the Bureau is foster mother to the millions of bass and trout fingerlings used to stock their favorite streams. To the commercial fishery operator, the Bureau is the source of fishery statistics by which he may guide his business. To the student of natural history, the Bureau is a rich treasure house of information regarding the biology of aquatic animals. To the fishery administrator, the Bureau offers sound and disinterested advice regarding the management of a natural resource.

True as these individual impressions may be, they must be taken in their entirety and in their proper perspective to gain a knowledge of the functions of one of the oldest conservation agencies of the Federal Government. Too often, I fear, people of the interior assume that the Bureau's attention is directed chiefly toward the commercial fisheries of our sea-coast states. On the other hand the commercial fishermen may think that chief attention is given to the anglers' demands for hatching game fish for streams and lakes. These misunderstandings have arisen because more attention has been given in the past to research than to public education in the

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1/ Presented Before the Second North American Wild Life Conference, St. Louis, Missouri, March 2, 1937.

principles of conservation. The Bureau's work has never been advertised or dramatized sufficiently to catch the public's imagination, but for achievements in the field of conservation we are content to stand upon our record. "By their works ye shall know them."

The primary functions of the Bureau of Fisheries are largely investigational and advisory to the states. Formed by a joint resolution of Congress in 1871 the U. S. Commission of Fish and Fisheries, as it was then known, was charged with the duty of determining what diminution in the fish supply of our coastal waters, streams and lakes had occurred, to discover what caused the decline and to recommend remedial measures. Biological investigation was, therefore, the first duty of the Bureau but the collection of statistics of commercial fisheries was undertaken at an early date and in more recent years has been amplified with the view to supplying practical aid to the fishing industry. Recognizing the need, however, for making effective some of its recommendations regarding the maintenance of the supply, the Bureau was granted authority to undertake the artificial propagation of fish, and the hatching and planting of food and game fishes soon became the most extensive branch of the service.

Twenty years ago in addition to investigational and fish cultural activities the Bureau was authorized by law to exercise control over the salmon and other fishes of Alaska, to regulate and supervise the Alaska fur seals and all fur-bearing animals of the Territory, to exercise control over the sponge fishery off the Florida coast, and to act as advisors to the states regarding fisheries legislation. Since that time various additions to the Bureau's duties have been imposed. For example, in 1920 the protection of walruses and sea lions in Alaska was transferred to the Secretary of Commerce and the regulation of fur-bearing animals in Alaska was transferred to the Secretary of Agriculture. In 1922 the Bureau was authorized to conduct the rescue of fishes from flooded areas throughout the Mississippi Valley and to propagate mussels. In 1924 it was given administrative control over fishery matters in the upper Mississippi wildlife and fish refuge. The authority of the Bureau of Fisheries in Alaska was extended at the same time to permit complete regulation of the fisheries. In 1930 enforcement of the Federal black bass law was entrusted to the Bureau. In 1935 the Bureau was charged with the administration of the act authorizing the formation of cooperative associations of fish producers, and in 1936 the Secretary of Commerce was given power to issue regulations jointly with the Secretary of the Treasury governing the whale fishery under the international whale treaty.

Let us look at the record, then, and review the accomplishments during recent years.

Biological Investigations.

Biological studies which form the foundation of all activities in the field of conservation are directed toward the mastery of natural forces to permit the full utilization of the natural supply of food and game fishes without future impairment and are divided into three major fields: aquiculture, or the cultivation and manage-

ment of fresh water fishes; commercial fishery investigations; and improvements in the farming of shellfish crops.

The problems of the fresh water fisheries throughout the country at present are concerned chiefly with increasing hatchery output and stocking interior waters. Through 10 years of research cures have been found for several bacterial diseases such as gill disease and a number of protozoan parasite diseases, and by practical experiment fish diets have been improved until one pound of trout can be produced from three pounds of food, with an increase in feeding efficiency of about one-third, combined with material saving in cost. To improve hatchery methods and efficiency the Bureau will continue the issuance of its monthly memorandum, THE PROGRESSIVE FISH CULTURIST, as an experiment in the education of hatchery personnel which has amply justified itself.

Another outstanding problem in maintaining good fishing conditions in interior waters is concerned with the development of a stocking policy. Test streams and lakes have been set aside in various sections of the country as demonstration and research units to test methods of stocking. The Bureau is cooperating with the Forest Service in devising better management of fishery resources comparable with the improved game management program. One-sixth of the waters of our national forests have been surveyed with the result that many miles formerly stocked have been shown to be worthless and that many more miles can be made more productive by judicious stream improvement. These services will be continued and expanded in the future.

Great progress has been made in determining the effect of stream pollution on aquatic life. The classification of pollution substances according to their biological effects and the standardization of their potencies have permitted the formulation of standards of water purity which will form the basis of a nation-wide policy for stream purification and protection.

During the past ten years progress has been made in determining the causes of great changes in abundance of commercial fishes. During the period continued observation of the trend and condition of the fisheries has revealed dangers of depletion and abuses in commercial practice that menace the supply. In New England, studies on the condition of the great haddock fishery have revealed the progress of over-fishing and recommendations for the use of savings gear to prevent the destruction of undersized fish have been adopted by the great fleet of trawlers.

Predictions of the yield of mackerel are of economic value for they permit the industry to take advantage of natural changes in abundance and will reveal depletion in its earliest stages should it occur.

Similar knowledge of changed conditions in the Middle and South Atlantic fishery has been acquired. The Bureau can now direct the fishermen where and when to make the best catches in this region and will be fore-warned of over-exploitation which has already affected the supply of squeteague, or weakfish.

The shrimp fishery of the South Atlantic and Gulf Coast is in a precarious condition as revealed by recent studies of the brief life history and migrations of the animal and will be watched continuously by scientific observers.

Increased knowledge of the migrations, habits, and variations in reproduction of the salmon on the Pacific Coast and in Alaska, which supports a $42,000,000 industry, assures its continued productivity.

Recent scientific studies make us optimistic that the $10,000,000 Columbia River salmon fishery, menaced by hydro-electric dams and irrigation works, can be saved and perpetuated on virtually its present scale of magnitude.

Shell fishery investigations are devoted chiefly to improvements in the cultivation of oysters by private growers and on the public beds. A more complete understanding of the biology of the oyster acquired in recent years has been practically applied by the industry in increasing seed production and in managing the crops. Methods have been devised during the past two years for protecting oyster farms from the ravages of destructive pests such as the starfish and the drill which heretofore have caused tremendous losses. Continued advice is offered to the industry that produces one of our most valuable aquatic crops.

Statistical and Technological Investigations.

The statistical investigations of the Bureau which have been conducted since 1880 provide an inventory of the catch of commercial fishes and a measure of the magnitude of the trade in fishery products. Moreover, records over such a period of years give some indication of the condition of the fishery resource. These statistics show the productivity of the fishery, the output of preserved products, the units engaged in capture and processing including the number of fishermen, boats and fishing devices, and the holdings of fishery products in cold storage on a monthly basis, all of which information is released at frequent intervals, as well as compiled annually for the use of the trade.

The interests of conservation are also served after the catch has been landed by encouraging proper utilization. Waste, spoilage, deterioration, or uneconomic use imposes an additional strain on the fish supply. In order to meet the needs of the industry the Bureau's technological studies are directed, therefore, to the better use of fishery products through improvement in processing for market, better methods of preservation including canning, smoking and salting, and proper icing, refrigeration, and distribution.

The Bureau has developed safe methods of home canning of many species of fish and shellfish and new methods have been developed for testing by electrical methods the relative freshness of fish in order to guard the quality of fishery products that reach the consumer.

Studies of the mineral content of seafood, including in particular iodine, have demonstrated their peculiar and important dietary properties and have helped to place oysters in the diet of those suffering from nutritional anemia.

The discovery of vitamins A and D in unusual quantities in various fish liver oils has led to the development of a considerable trade in such excellent vitamin concentrates as halibut, swordfish, and tuna liver oils. Great quantities of sardine oil are used annually by poultry and stock growers in the United States as a regular source of vitamins, displacing high priced cod liver oil imported from abroad.

Another saving to the country and to our fisheries has been the development of by-products of the fisheries, including the use of fish oils in a great number of industrial processes. The wastes of canning and filleting processes are now also utilized in producing a higher grade of fish meal for animal feeding.

Fish Cultural Activities.

The Bureau operates 88 major fish hatcheries throughout the United States. Under the 5-year program authorized by Congress in 1930, 30 new hatcheries were planned but of this number the construction of only 16 was actually started. With P. W. A. and other emergency funds, however, the completion of many of these projects was made possible. In all, extensive improvements were made to some 37 hatchery projects involving an expenditure of approximately $450,000 of emergency funds.

The net result has been the enlargement and overhauling of the Federal hatchery system to a condition where it is better adapted to meet the requirements of stocking with both food and game varieties, and particularly to provide large numbers of fish for areas under Federal control. This does not mean that the perfect setup has been achieved, but by the placement of a moderate number of new hatcheries in regions not now adequately served and by improvement of efficiency through the completion or rehabilitation of existing hatcheries, we could easily take care of all reasonable demands. I do not favor an indefinite expansion and enlargement of the Federal hatchery system.

The most outstanding accomplishment during the past year is the posting of an all-time record for the distribution of fish and eggs. Eight billion, one hundred seventy million was the output of our hatcheries during the fiscl year 1936. Billions of these consisted of the eggs and fry of commercial species, but since this work was largely carried on as a by-product recovery and the unit costs are extremely low, I consider it entirely justified. This accomplishment was achieved with appropriations of approximately 60 percent of the amount expended on the hatcheries five years ago.

We also feel that the past year has been one of the most fruitful in the services of a strictly advisory and technical capacity rendered to other fish cultural agencies. Cooperation with the State hatchery services has been greater and more valuable to both sides than in any previous year.

Law Enforcement.

Alaska Service - The primary objectives of the Bureau of Fisheries in Alaska are to conserve the salmon and other fisheries, and to protect and maintain the fur-seal herd of the Pribilof Islands.

The first objective - the conservation of the fisheries - has been achieved by the promulgation of well-founded regulations coupled with rigid enforcement.

The Alaska fishery regulations are based upon a knowledge of the life history and habits of the various species, and an estimate of the abundance of each. Regulations of this nature have been issued annually since 1924, and supplementary regulations have been issued from time to time during each season to compensate for unforeseen changes in abundance.

The conservation policy with respect to the Alaska fisheries has yielded extremely gratifying results. Instead of a downward trend in production, characteistic of so many of our great fisheries, the trend in the Alaska salmon fishery is upward, and the runs in the year just passed yielded 8,400,000 cases, the largest pack of canned salmon in the 59 years of commercial operations in the Territory. The second largest pack, 7,500,000 cases of canned salmon, was produced in 1934.

The success with which the Pribilof Islands fur-seal herd has been restored is well known among conservationists. When the treaty between Canada, Russia, Japan and the United States became effective in 1911, the herd had dwindled to about 125,000 animals. Today the herd numbers about 1,690,000 animals, and in the period since 1911 the Government has taken 700,000 pelts from surplus male seals. This phenomenal record has been possible through careful management, which has taken into consideration all phases of the natural history of fur seals.

Black Bass. - Originally passed by Congress in 1926 and amended in 1930, the Federal black bass law prohibits the shipment in interstate commerce of black bass taken in violation of state laws.

Since the passage of the Federal law a number of states have prohibited the sale of black bass at all times regardless of where taken, and many other laws have been adopted along the lines suggested by the Bureau. There are 38 states that now prohibit the sale of black bass regardless of where taken and 6 additional prohibit their sale if caught within the state. Conditions in the 4 remaining states are far from satisfactory.

The actual enforcement of the Federal law has greatly reduced interstate shipments of black bass, legal and illegal, and the black bass is becoming more and more a species reserved for sport, and less of a commercial product.

Conclusion

I wish to emphasize the fact that throughout all of this work there is an essential unity in aim, method and administrative organization that cannot be disturbed without sacrificing practical accomplishments in the field of fishery conservation. The Bureau of Fisheries is the sole governmental agency concerned with the promotion, management, and conservation of both the fresh water and marine fishery resources of the nation. The functions of its various technical and administrative divisions are nicely balanced and integrated for effetive work. Its research activities are equally distributed among the commercial marine fisheries, the commercial fisheries of interior waters, and the sports fisheries. Principles and techniques developed by its trained staff are applicable to all aquatic animals. Artificial propagation and stocking includes marine, anadromous and fresh water species, and the work is guided by our technical personnel. Separation of these functions of conservation of the commercial marine fisheries and fresh water fisheries, as has been proposed by some who labor under misunderstanding, would result in the immediate loss of efficiency and would require additional expenditures through the duplication of function and personnel.

During the past 10 years there is discernible a definite trend toward the clarification of aims and purposes - toward the definition of a coherent and comprehensive program of fishery management that has gained sufficient momentum to effectively discourage counter tendencies to dissipate energies and scatter attention to minor and temporary projects. In recognition of its services to the nation there is likewise a growing tendency to expand the Bureau's field of work and more adequately finance its operations. This tendency must not be checked if the destructive forces of civilization inimical to conservation are to be overcome. If our march of progress continues, the next few years will witness progress more satisfying than ever before in acquiring complete mastery over the fisheries of interior waters and eternal vigilance for the safety of our marine fishery resources will permit the full utilization of our great food supplies in the sea on a permanent and stabilized basis without fear of ultimate disaster.

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THE ARTIFICIAL PROPAGATION OF THE COMMERCIAL SPECIES OF FISH OF THE GREAT LAKES 2/

By Dr. John Van Oosten, In Charge

Great Lakes Fishery Investigations, U. S. Bureau of Fisheries.

Introduction.

IN DISCUSSING the subject of artificial propagation of fish the Great Lakes must be considered apart from the smaller inland lakes and streams. The fishery problems on the Great Lakes cannot as a rule be solved by exactly the same technique that is employed on smaller bodies of water. Not only does the size of the Great Lakes prevent this, but also the magnitude of their fish populations. For example, most of the states fronting the Great Lakes, as well as the Bureau of Fisheries, have adopted the policy of planting fingerlings or larger fish instead of fry in the inland lakes and streams. But none of these states nor the Bureau of Fisheries has attempted to follow the same policy on the Great Lakes. Why? Simply because they cannot afford to rear the bigger fish in sufficiently large numbers to stock effectively such large bodies of water as the Great Lakes.

Sentiment with Respect to Artificial Propagation on the Great Lakes.

Because planting must be confined to fry and because certain undesirable features have developed in connection with the collection of spawn during closed seasons, there has arisen a sharp difference of opinion among the officials of the conservation departments of the various governments involved with respct to the fish cultural policy that should be adopted on the Great Lakes. 2/ Michigan, although it does not condemn artificial propagation as such, does believe that the harm done by the objectionable features has far outweighed the benefits that may have resulted from the planting of fry. Michigan questions the possibility of eliminating these features. It is for this reason primarily that this State has abolished the permit system, under which fishermen were issued special permits to catch and market fish during the closed seasons for the purpose of collecting spawn, and has since 1933 enforced a strictly closed season on the various species of commercial fish, although all spawn collected during the open seasons has been incubated at the hatcheries. Illinois officials are inclined to accept the Michigan point of view, but have not yet adopted permanently Michigan's policy of a strictly closed season. Indiana does not collect spawn from the commercial fish of Lake Michigan. Wisconsin and Minnesota officials,

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2/ Presented before the Second North American Wild Life Conference, St. Louis, Mo., March 3, 1937.

however, believe that the results of planting fry in the Great Lakes justify the continuation of the permit system in spite of its undesirable aspects. Ohio, Pennsylvania, New York, and Ontario have no closed seasons designed to protect the spawning fish of the Great Lakes, but their licensed commercial fishermen must collect spawn as directed. I do not know the official attitude of these three States toward the question of permits versus strictly closed seasons, but Ontario believes that artificial propagation is far superior to natural propagation in maintaining the fisheries. During the past three years the Bureau of Fisheries has discontinued the operation of several of its Great Lakes hatcheries for commercial fish not only because of lack of funds, but also because of the questionable effectiveness of collecting eggs under the permit system and planting fry, and because of the lack of proper regulations to protect the baby fish until they reach maturity.

The commercial fishermen themselves do not agree in their views concerning artificial propagation and related questions. By means of a questionnaire submitted in 1928 to a selected group of fishermen on Lake Erie and in 1932 to all the licensed commercial fishermen of Michigan and Wisconsin, it was determined that 68 percent of the 767 men who responded favored the hatcheries, that of the 648 who replied, 46 percent favored the permit system of collecting eggs, 45 percent favored a strictly closed season during the spawning period, and 9 percent favored restricted fishing for spawn under direct governmental supervision. The detailed data of the accompanying table show that on every lake and in every state the majority of the fishermen favored artificial propagation although there was a wide range in the size of the different majorities. With respect to the question of permits, however, there was a greater diversity of opinions. The majority of the Michigan fishermen on Lakes Huron and Michigan favored a strictly closed season, but those on Lakes Erie and Superior favored the permit system. The Wisconsin fishermen of Lake Michigan favored a strictly closed season, but those of Green Bay favored the permit system, while those of Lake Superior were equally divided on the question.

Opinions of Great Lakes Commercial Fishermen
re Hatcheries and Closed Seasons
as Shown by Questionnaires.

State	Lake	Are hatcheries beneficial to commercial fishing? Yes	No	What type of closed season do you favor? Completely closed; no fishing	Issue spawn collecting permits to all fishermen	Limit permits under state and federal supervision	Total
Michigan	Michigan	111 (60) 1/	73 (40)	97 (57) 1/	52 (30)	22 (13)	171
	Huron	59 (63)	35 (37)	36 (48)	32 (43)	7 (9)	75
	Superior	99 (86)	16 (14)	18 (19)	68 (71)	10 (10)	96
	Erie	30 (97)	1 (3)	5 (22)	18 (78)	---	23
	Entire State	299 (71)	125 (29)	156 (43)	170 (46)	39 (11)	365
Wisconsin	Superior	44 (72)	17 (28)	28 (50)	28 (50)	---	56
	Michigan (excl. Green Bay)	39 (53)	35 (47)	35 (66)	14 (26)	4 (8)	53
	Green Bay	105 (63)	63 (37)	68 (42)	80 (50)	14 (8)	162
	Entire State	188 (62)	115 (38)	131 (48)	122 (45)	18 (7)	271
Ohio	Erie	25 (96)	1 (4)	1 2/	2	1	4
Pennsylvania	Erie	2 (50)	2 (50)	3	-	-	3
New York	Erie	9 (90)	1 (10)	-	5	-	5
United States (incl. Mich.)	Erie	66 (93)	5 (7)	9 (26)	25 (71)	1 (3)	35
Canada	Erie	12 (92)	1 (8)	1	3	2	6
United States	All lakes	523 (68)	244 (32)	291 (45)	299 (46)	58 (9)	648

1/ Numbers in parenthesis are percentages.

2/ Very few fishermen on Lake Erie favor closed seasons during spawning periods and therefore only few had occasion to answer this question. Most of them believe in artificial propagation and therefore would favor a permit system.

Problems Involved

An outsider must no doubt wonder why after more than 50 years of artificial propagation of fish on the Great Lakes there should still be so much controversy among all interested groups concerning the effectiveness of this work. Why were the results of fish cultural efforts not checked years ago? Aside from the fact that very few research men were available years ago, the solution of the question involves almost unsurmountable difficulties. It is virtually impossible to check directly the results of the introduction of fry into the Great Lakes. We can not follow the history of the fish after their liberation into the lake and, therefore, cannot obtain direct, critical data on their survival. Assuming, however, that such data on survival could be obtained we would still have to know something about the number of eggs produced and fertilized under natural conditions and the percentage of survival of these to the fry stage in order to determine the ratio of the number of fry introduced to that already present in the lake. In most of our commercial species of fish in the Great Lakes we do not even know where the fry go after hatching nor anything about their habits and movements let alone the determination of their numbers.

There is, of course, an indirect method of attack which may provide critical data, that is, a study of the correlation of the number of fry planted and the size of the commercial catch in subsequent years. Even this method is not foolproof except perhaps when a negative correlation is found to exist. If a positive correlation were found we would still have to prove that it was not due to the abundance of naturally produced fry and their survival.

To employ this indirect method it is necessary to have reliable statistics on the number of fry actually planted, on the abundance of the commercial catch in terms of fishing intensity, and on the age composition and the relative abundance of the various year classes or broods in the commercial catch. Such data are now being accumulated for the more important species of the Great Lakes by the Bureau's laboratory at Ann Arbor, Michigan.

Criteria of Artificial Propagation

Because there are not enough decisive and critical scientific data either to defend or condemn unqualifiedly the artificial propagation of the commercial species of fish of the Great Lakes, present opinions must be based largely on indirect criteria. I believe that these criteria justify a skeptical attitude toward fish cultural efforts on the Great Lakes and suggest that the effectiveness of artificial propagation has been overemphasized and that of natural propagation underestimated. The evidences are summarized below.

1. No correlation has been found so far between the number of fry planted and the resultant catch of adults in subsequent years. The generally accepted belief among the fishermen that the increase in the abundance of yellow pike-perch in Saginaw Bay in the years 1932-35 was the result of the heavy plants of fry has been found to be untenable. Recent analysis showed that no such correlation exists. Further,

it was shown that this species also increased in abundance in the Michigan waters of southern Lake Huron, Green Bay, and southern Lake Michigan where no fry were planted that could account for the improved condition (Hile, 1937). Negative correlations were obtained also by other investigators for other waters. Odell and Senning (1936) found no correlation between fry plants and abundance of age groups in the whitefish of Otsego Lake, N. Y. The second most abundant age group (5+) originated in 1930 when no fish were planted. Likewise Wagler (1931) could discover no direct relation between the size of fry plants and catch in the whitefish of Lake Constance during a period of 15 years.

It might also be mentioned here that the non-proagated species of fish of the Great Lakes, such as the blue pike, saugers, yellow perch, and herring, have undergone no greater depletion than the artificially propagated species such as the cisco, whitefish, and lake trout.

Many proponents of artificial propagation on the Great Lakes point repeatedly to increased annual yields in local waters as evidence of the effectiveness of planting fry. They do so, however, without any data on natural fluctuations, on migration of fish, or on the age at which the fish of a year class appear in the catch.

2. Fish culturists, as a rule, have greatly underestimated the effectiveness of natural propagation and overestimated that of artificial propagation on the Great Lakes. It has been asserted repeatedly that, on the average, not more than one per-cent of the eggs deposited naturally by such species as the whitefish, lake trout, and pike-perch are fertilized or survive, and that at least ten percent of the fry liberated in the Great Lakes by the hatcheries reach maturity if not destroyed by other than natural causes, although none of the early fish culturists ventured to offer a guess on the survival of fry in nature.

A search of the literature revealed some startling information on the fertilization of fish eggs in nature. Specific data were found on 14 species, 11 of which enter the commercial catch. Of the 25 records obtained 17 showed a fertilization of 80 to 100 percent, 3 of 62 to 66 percent, 4 of 22 to 45 percent, and 1 of 1.6 percent. Data on survival in nature are more difficult to obtain and hence are more meagre. Two species (whitefish and brook trout) showed a survival of 13 and 80 percent respectively to the eyed stage, and four species (whitefish, coho salmon, quinnat salmon, and Pacific herring) showed a survival of 5.7, 30, 70, and 95 percent respectively to the fry stage.

The most elaborate study involved the sockeye salmon of British Columbia (Foerster, 1931, 1934, 1936a, 1936b). Dr. Foerster's data show that 1.13, 1.05, and 3.16 percent respectively of all eggs that were available for natural deposition in Cultus Lake in 1925, 1927, and 1930 developed into seaward migrants, and that .03 percent of the eggs that were available in 1925 and 3 percent of the seaward migrants resulting from these eggs survived to return as adults. In the case of artificial propagation in the years 1926, 1929, and 1932 respectively 3.93, 2.38, and 1.71 percent of all available eggs, 4.54, 2.76, and 2.43 percent of all eggs available for stripping,

and 5.83, 3.86, and 2.81 percent of the fry liberated in the lake developed into seaward migrants, and .09 percent of the eggs available in 1926 and 2.3 percent of the seaward migrants resulting from these eggs survived to return as adults. The artificially fertilized eggs collected in 1928 and 1933 and planted in the eyed stage produced seaward migrants that represented a survival of 0.95 and 3.57 percent respectively of all available eggs, 1.44 and 4.69 percent of the eggs available for stripping, and 1.64 and 5.58 percent of the eyed eggs planted. Dr. Foerster concluded that since the percentage efficiency was found to vary from 1.0 to 3.0 percent with natural spawning, from 1.7 to 4.5 percent when artificially propagated fry were liberated, and from 1.0 to 4.7 percent when eyed eggs were planted, artificial propagation had no significant advantage over natural propagation in Cultus Lake.

The above data on the percentage fertilization in nature, on the survival to the eyed or fry stage, and on the survival of fry liberated in the lake suggest that the most crucial period in the life history of the fish occurs subsequent to the fry stage, perhaps during the first year of life. If this is true for the Great Lakes fish also then the planting of fry can have but little effect on the fisheries of these lakes. If the heavy mortality of this period results from a scarcity of food the addition of fry to the lake by the hatcheries would be definitely deleterious to the fisheries.

The ratio of the number of eggs collected by the hatcheries to the number naturally deposited in the lake has a definite bearing on the problem under consideration. The only published data on such ratios, so far as I know, are those of Dr. Foerster (1936b). These indicate that on the average the number of sockeye salmon eggs collected varied from 2.5 to 4.7 percent of the eggs spawned naturally, "proportions not expected to alter to any appreciable degree the extent of the fishery....."

3. Fish culturists have in general underestimated the loss of eggs to the lake during spawn operations and have emphasized too much the percentage of survival of the eggs that reach the hatchery. This emphasis has in the past obscured the real loss of eggs. Let me illustrate. Dr. Elster (1935, 1936) found that in the whitefish, Coregonus wartmanni, 70 80 percent of the eggs delivered to the hatchery survived to the planting stage (loss of 20-30 percent). If, however, the entire loss of eggs to the lake was considered the hatchery output for three years represented a survival of only 10.8, 16.3, and 18 percent (losses of 82, 83.7 and 89.2 percent).

Similarly Dr. Foerster (1931, 1936a, b) showed that in the sockeye salmon the percentages of loss of eggs based on the quantity of eggs brought to the hatchery were 7.5, 18.1, and 10.9 respectively in the 1926, 1929, and 1932 experiments, but if based on the potential take of eggs from the stripped fish (12.6 percent of the eggs were left in the body after stripping) the percentages would be 22.1, 28.5, and 13.8 respectively, and if based on the total loss of all available eggs (13.4 percent of the eggs were lost because of dead fish) the percentages for 1926 and 1929 would be 32.5 and 38.3 respectively.

On the Great Lakes it is pointed out repeatedly that on the average 60 to 65 percent of the lake trout and whitefish eggs and about 45 percent of the yellow pike-perch eggs survive in the hatcheries (losses of 37, 34, and 55 percent respectively). But if these percentages of survival were translated into figures based on the total number of eggs removed from the lakes during spawn operations computations show that they would be at most: 15, 9, and 6 percent. Confronted with losses of 85, 91, and 94 percent the defense of artificial propagation becomes decidedly more difficult.

4. The critics of artificial propagation on the Great Lakes also emphasize the point that to catch fish when they are segregated on the spawning grounds is to attack the species at the most vulnerable period of its existence. Michigan statistics show, however, that during the years 1928-32 the catch of lake trout and whitefish (some of which were spent fish) taken during spawn operations represented only 10.9 and 3.6 percent respectively of the total catch.

Other criticisms are largely economic or involve questions of proper restrictions and enforcement. It is asserted that spawning fish are not in the best condition for human consumption, that the sudden increase in production during the spawning runs gluts the market and ruins prices until the surplus has been sold. From the enforcement angle it is pointed out that most States are not equipped to enforce the restrictions under which permits are issued, and as a result an excessive number of nets are set resulting in the destruction of many spawners and the loss of large numbers of eggs.

In this paper I have attempted to point out briefly the sentiment with respect to artificial propagation on the Great Lakes, the problems that must be solved in order to judge critically the effectiveness of artificial propagation on the Great Lakes, and the criteria that are available upon which present opinions must rest. Although we do not have a sufficient amount of direct evidence either to condemn or defend artificial propagation on the Great Lakes, indirect criteria seem to point to the fact that the effectiveness of artificial propagation has been greatly overemphasized and that of natural propagation greatly underestimated. All evidence point to the fact that "Old Mother Nature" is not quite as sterile as the enthusiastic supporters of artificial propagation have led us to believe.

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RESULTS OF EXPERIMENTAL BASS STUDIES

By E. W. Surber and J. S. Gutsell

U. S. Fisheries Station, Leetown, W. Va.

IN APRIL 1936 four-mile experimental sections were established on two bass streams, the South Branch of the Potomac River near Romney, W. Va. and the Shenandoah River near Berryville, Va. Anglers were requested to leave reports after each fishing trip. The reporting of catches was on a voluntary basis, and on the South Branch, particularly, the cooperation of the anglers was not good. However, their reports did yield a few facts as the following: The average length of legal Shenandoah River bass exceeded that of South Branch bass (13.3 as compared to 11.9); the proportion of undersized bass taken in the South Branch was greater (Shenandoah 132 legal bass - 80 undersized bass: South Branch 150 legal bass - 161 undersized bass). 35 sunfish were taken in the South Branch as compared to 20 in the Shenandoah River. On the other hand, catfish were more abundant in the Shenandoah River than in the South Branch (59:20).

The growth of the young bass of the current season was followed from the time the fry rose from their nests until about the end of the growing season, and it was found that Shenandoah River bass reached an average length of about 4.25 inches at the end of the season, as compared to 2.75 inches in the South Branch. Growth rates of fish associates of these bass in the same collections were also studied and it was found that all species dealt with grew faster in the Shanandoah, the larger stream. Stone rollers (spotted suckers), common suckers, fallfish, stone-roller minnows were among the species of fish which grew too rapidly for the average fingerling bass to utilize as food during the current season. The most desirable minnow for fingerling bass in both rivers appeared to be the blunt-nosed minnow, which had successive broods of young that were small enough for the average fingerling bass to consume. Minnows in general appeared less abundant in the South Branch than in the Shenandoah River while bass were far more abundant per unit area in the South Branch.

On May 1 and 2, 1936, a total of 142 bass nests were counted in the South Branch, 72 of which contained eggs. The Shenandoah River was not as clear during the spawning season, but a 1 m. m. platinum wire was visible at a depth of 39 inches, and only two nests were found in a survey of one bank on April 30. Two more were found about two weeks later. The bass chose places where the current was sluggish, and in the South Branch, at least, did not spawn on bed rock. In several places they went down through several inches of a sand covered bottom to reach gravel beds. The average depth of the nests observed in the South Branch was 31 inches, the minimum 13 and the

maximum 68 inches. The output of fry from natural propagation is estimated in the South Branch four-mile section to have been at least 216,000. This fact, as well as others mentioned below, brings up the question of the utility or futility of stocking a stream such as this with hatchery reared fish. In stocking such rivers as the Shenandoah, some improvement might be expected.

Growth studies from scale samples collected from 68 South Branch bass taken on hook and line and 171 Shenandoah bass showed that very few South Branch bass attain the legal length of 10 inches before their fourth year, while nearly all Shenandoah bass reached the legal size in their third year. The rapid growth of Shenandoah River fingerlings was made in spite of the fact that the river was muddy throughout the summer. Muddy water may actually be a benefit to bass in enabling them to catch other fish.

In the South Branch there is a preponderance of bass just under the legal size. It seems that a temporary reduction in the legal length from 10 to nine inches would reduce the present overstocked condition and ultimately lead to a better growth rate through less competition for food.

Quantitative bottom samples were taken in the riffles of both rivers. The average number and weight of bottom animals in the Shenandoah riffles were somewhat higher than the South Branch. Hellgrammites, certain mollusks (Sphaerium and Margaritana), caddis larvae (Hydropsyche) and oligochaets were more abundant in the Shenandoah River, while snails, crayfish, and certain fly larvae as Atherix and Eriocera were more abundant in the South Branch. Some species of insects such as Potamanthus, Ephoron, Elophila were common to both streams.

A marked difference in the number of parasites in the livers of Shenandoah and South Branch bass has been noted. The livers of nearly all fingerling South Branch bass contained encysted flatworms (Strigeidae) while those of the Shenandoah River fingerlings were nearly free of parasites. In some fish the livers were swollen to such an extent that the small bass gave a false appearance of having full stomachs.

ABSTRACTS OF SELECTED PAPERS PRESENTED BEFORE THE NORTH AMERICAN WILDLIFE CONFERENCE, ST. LOUIS, MO., MARCH 1-4, 1937

PROVIDING SHELTER, FOOD, AND SPAWNING FACILITIES FOR THE GAME FISHES OF OUR INLAND LAKES

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LAKE IMPROVEMENT, as used in this paper, signifies the creation and maintenance in our inland lakes of conditions which favor an abundant crop of game fih. The promise of lake improvement is based on three premises: (1) lake fishes require more than pure water in which to survive, grow, and multiply; (2) such essential conditions as shelter, food, and spawning facilities are often so deficient as to limit production of lake fish; (3) it is practicable to increase the yield of lake fish by building up the deficient factors.

Lake improvement and the better known and more thoroughly tested activity of stream improvement rest on the same biological basis and together comprise a main branch of fish management.

After the first evidence that the game fish supply was becoming depleted, laws were passed to limit and regulate the catch. As depletion nevertheless continued, exotic species were introduced and a few desired fishes were artificially propagated. Despite partial or temporary successes, the supply of game fish has continued to decline, and a program of lake and stream management is now proposed to supplement fish culture, much as fish culture has supplemented restrictive legislation.

For maximum effectiveness of this program, it is important: (1) that research on the methods and results of lake improvement be expanded and intensified; (2) that more men be trained for research and installation of improvements: (3) that demonstrations of lake improvement methods be set up as soon as they are sufficiently studied and tested; (4) that adequate funds be provided to support this research.

Such a program is necessary not only to increase fishing but also because of the harmful incidental results of certain of man's activities. Deforestation, drainage, and cultivation of land have converted fine lakes into marshes and alkali flats; soil erosion has smothered productive lake shoals with silt; dumping of sewerage has so increased the organic content of some lakes as to produce excessive growth of noxious algae. Many changes made even under the name of "improvement" have made lake environments less favorable for fishes.

Most of the deficiencies in the environment are thus the work of man, not of nature, and by effective improvement the fish supply may be not only conserved but also increased.

The first step in lake improvement is to determine what factors are limiting the abundance of game fish. The next is to modify each factor so that it will contribute to a larger and more dependable crop. Conditions should be adjusted to make the lake a self-sustaining biological unit. The weakest element in the fish-producing environment should be built up first, so as to provide the maximum fish population that can be maintained by other environmental conditions. Some other factor may then become undeveloped in terms of the increased population. The balance would thus tend to be successively overthrown, and each attempt at restoring it should lead in a cumulative way to greater fish production. This process should be continued to the practical limit, which will depend on the intensity of fishing and on the economic values involved.

An intensive survey of aquatic conditions which may control fish production should precede the actual operations of lake improvement, which should be conducted by experienced men. Later checks should be made on the permanence and effectiveness of the improvements.

R. L. C.

THE MANAGEMENT OF IMPOUNDED WATERS

By Dr. A. R. Cahn, Chief, Biological Readjustment Unit, Forestry Division, Tennessee Valley Authority.

RECOGNIZING THE FACT that impounded waters demand biological attention in order to prevent their degeneration as a source of aquatic life, the Tennessee Valley Authority created within its Forestry Division the Biological Readjustment Unit, charged with the study, development, and maintenance of the game and fish resources of the Tennessee Valley.

The Tennessee Valley has been divided into five working areas, each composed of contiguous reservoir areas, for the collection of scientific data on the life history of impounded waters.

It is planned to work under a cooperative agreement with the seven states involved whereby each state will enforce such regulations or limitations as the TVA may deem it advisable to place on the utilization of wildlife resources.

The fisheries program may be divided into two main categories. The first consists of fisheries studies to determine what species of game and rough fish inhabit the watershed, their abundance, distribution, and life histories, the presence and abundance of forage fish, the possible extermination of predatory fish, and the problem of fish-eating birds; to provide for stream improvement to establish better facilities for spawning, shelter, feeding, etc.; and to stock the lake and its tributaries with fish reared at Norris Hatchery and in other rearing ponds. Other studies will concern Norris Lake as a home for fish, the seasonal and vertical distribution of gases, the problem of pollution, the productivity of the water as indicated by plankton and bottom organisms, and studies of the potential productivity of the water through surveys of available nitrogen, phosphorus, and carbon

By means of such a comprehensive study of the fauna of the original Tennessee River System prior to metamorphosis, it will be possible in years to come to describe in an intelligent manner just what has happened following the evolution of a great river into a series of great reservoirs, to determine the effect of this change on species presence and species abundance, on the disappearance of original species or the blossoming out of old ones in new abundance. The study should provide information on how best to promote the further increase of those species which, directly or indirectly, are of value to Man. The most important problem is how to replenish new waters with adaptable life, not primarily for recreation or sport, but to keep up a food supply upon which many inhabitants of the Valley have been largely dependent.

R. L. C.

MANAGEMENT OF IMPOUNDED WATERS IN OHIO

By E. L. Wickliffe and Lee S. Roach
Ohio Division of Conservation

IN 1930 THE OHIO DIVISION of Conservation began a limnological investigation of its ponds, lakes, and reservoirs primarily to determine their suitability for natural propagation and for stocking hatchery fingerlings and Lake Erie breeder fish. Ninety percent of these waters are impounded.

When a typical small-mouth - rock bass stream is impounded by a high dam, the reservoir habitat is entirely different from the original stream conditions and the native wildlife must either adapt itself to the new conditions, move out, or die.

Previous reports by the authors stated that the white crappie becomes the dominant hook and line fish and apparently continues as such, although the bluegill and largemouth black bass follow when larger forms of aquatic vegetation are established. The gizzard shad is recommended as a forage fish because, being a vegetarian, it does not compete with game fish for food, cover, or breeding grounds and directly transforms plant food into game fish food. The dominant forage minnow of the impounded waters and streams studied is the bluntnose.

The following forage fish, arranged in the order of abundance, were found: gizzard shad, bluntnose minnow, golden shiner, brook silverside, log perch, and Johnny Darter.

A survey of Meander Creek in 1929, before the building of the reservoir, yielded 30 species of typical stream fish. In 1932 only 12 species were recorded for the newly flooded reservoir. Without doubt the number and pounds of fish increased with te flooding of the creek, although the number of species of fish decreased.

Impounded waters arranged according to their age indicate an abundance of entomostraca (baby fish food) within one month up to and including one year. Bottom organisms (mostly mosquito larvae) appeared within the first month. A moderate number of midge larvae were present within six months.

For the present program of stream improvement in Ohio it is recommended that: (1) riffles be retained to assist in aerating the water before it reaches the impounded pool, serve as a home for forage fishes, and form productive aquatic larval fish food habitats; (2) low dams should not increase the depth of natural pools in small streams to much over forty inches; (3) circulation through the impounded area be accomplished by a "V" notch or weir; (4) large flat stones or slabs be placed at an angle with the stream bottom above the dam where the bottom is sand, pebbles, or gravel; (5) low dams be placed below abandoned oxbows in streams to produce plankton and serve as natural rearing ponds.

POLLUTION AND SILTING CONTROL PLANS IN RELATION TO AQUATIC LIFE

By Dr. M. M. Ellis, In Charge, Interior Fisheries Investigations
U. S. Bureau of Fisheries

NO SINGLE PROCEDURE will serve to remedy the detrimental effects of stream pollution and silting on fishes and other aquatic life. Many proposed remedies are inadequate because they take account of only one of the many factors involved.

Barring practical difficulties in the cases of certain silts and wastes, exclusion is the logical procedure for industrial silts and a large number of industrial and municipal effluents. Exclusion of erosion silt involves enormous problems in flood control, reforestation, regrassing, and agricultural practices. While a national program of erosion control is getting under way, construction of dams serves as a compromise measure because some silt settles out in the impounded waters, which are themselves, however, subjected to all the primary and corollary hazards of silting. Laboratory experiments indicate that in the future erosion silt may be precipitated by changing the charge of the particles in suspension or by altering the value of the water.

Industrial silts constituting serious stream pollutants may in general be excluded very easily. Settling basins used in rotation, and for some silts supplemented with simple chemical treatment, remove all heavy particles and most of the colloidal material.

Industrial wastes other than silts, when merely heaped on the land may sooner or later contribute dangerous pollutants to nearby waters although the original wastes were not put in the stream. Piles of mine wastes, sawdust, chemical wastes and slags have been shown in specific instances to be sources of stream pollution.

Dilution is practicable only for wastes that are easily oxidized or readily neutralized, and then only if there is sufficient length of open water, proper agitation and suitable oxygenation.

Cumulative effects of effluents in dilutions not immediately lethal are often overlooked. Minute quantities of selenium, for example, do not kill or even disturb fish for days, but constant exposure produces pathological changes resulting in death in a few weeks. Dilution is therefore satisfactory only when possible cumulative effects have been ruled out.

Effluent treatment is the more modern means of stream purification. Sometimes the mixing of two effluents from the same plant, one acid and the other alkaline, produces a harmless product. Chemical treatment, usually relatively inexpensive, can be given to most industrial wastes.

None of the treatments recommended by sanitary engineers for organic wastes and sewerage can be accepted without change by fisheries interests, because all provide effluents having high oxygen demand, dangerous ammoniacal content, and sometimes harmful quantities of salts. The chlorinated effluent from Imhoff tanks is most hazardous to aquatic life. Accumulating evidence is leading health authorities to question the continued use of chlorinated water even by human beings, and its detrimental effect on aquatic life is well established.

Pollution and silting control plans must therefore consider collectively the types of hazards, the feasibility of the remedial measures proposed, and the success of these procedures in serving all legitimate interests in the waters under consideration.

R. L. C.

THE EFFECT OF SILTING ON THE PRODUCTIVITY OF WATERS

By Dr. Emmeline Moore, Chief Aquatic Biologist, New York State Conservation Department.

THE "SILT PROBLEM" is important in many of the far-reaching developments now under way toward a better conservation of water resources. Known methods of removing silt from reservoirs are usually impracticable or costly, and sometimes no method can be devised.

The term "silt" as commonly used by engineers includes all material transported by flowing water, whether carried in suspension or transported as bottom load. In the southwest, great reservoirs created by such dams as the Elephant Butte and Boulder Dam are slowly being deprived by silting of their power to store water, and in lesser degree problems of silting occur in all major and some very small stream systems.

To the biologist, silt refers more particularly to the finer particles, and the silt problem becomes important for other reasons than reducing the storage capacity. Silt cuts down also the productive capacity of the waters because of turbidity and the instability of bottom sediments. Where shifting sediments cover all exposed surfaces of the stream bed, the result is annihilation of fish life as well as the food supply throughout the stretch of heavy silting.

The existence of wildlife in a reservoir apparently depends to a considerable extent on the amount of silting that occurs. The Sacandaga storage reservoir, about the size of Lake George, lies in a valley of the Adirondack plateau consisting mainly of igneous rock covered with vegetation, largely of forest growth. There is no silt problem of consequence and the reservoir has recognized assets as a fishing water.

In the Ashokan Reservoir, however, water is discharged from Esopus Creek into the west basin where greatly increased silting has occurred in recent years. This silting is caused by the inflow of muddy water from the Schoharie Watershed where the soil of fine clay and shale is easily eroded. Severe floods and a large amount of steam shovel work to divert streams away from the roads are other factors in increasing the discharge of sediment. Studies reveal a very low transparency, a scarcity of green algae, and a low organic content for the water. Quantitative studies of the food organisms in the bottom muds showed that the west basin is poorer in food (as it is in fishing) than the east basin, where there is less silting.

Small attention has been given to the silt problem as it affects food production in reservoirs, yet this aspect deserves serious thought and in planning water conservation projects relating to wildlife. The larger problem, however, is one in which greater effort needs to be directed toward prevention of silting.

R. L. C.

RECOMMENDATIONS FOR IMPROVING BASS FISHING IN OHIO

By Dr. T. H. Langlois, Chief, Bureau of Fish Management and Propagation,
Ohio Division of Conservation

A PROGRAM for improving bass fishing in the streams of Ohio must consider the natural productiveness and fish carrying capacities of those waters and must so apply methods of managing aquatic habitats and stocks that the maximum sustained yield of fish will be obtained.

For several years the bass population has been dominated by year groups spawned in years when greater success attended bass reproduction, survival, and growth of young. The most successful spawning seasons have been the drought years, when waters were clear. In years of heavy rainfall, spawning was inhibited or eggs were spoiled by roily water. Sustained yield cannot be expected until conditions can be regulated so as to obtain regular annual additions to the bass population.

The silting over of fertile stream bottoms with nearly sterile subsoils can be prevented only by turfing the tributary valley slopes and reducing the silt load at its source. Growth of vegetation close to the stream margin increases the number of insects for fish food. The flooding of fertile oxbows by installing carefully placed small dams creates quiet zones where small crustaceans become abundant.

Bass fry feed on water fleas and other small crustacea. Later in the spring they begin to eat minnow fry and insects. Smallmouth bass subsist principally on crayfish during July and August, but turn again to feeding on minnows in September

when the crayfish burrow into banks. During the winter months bass congregate in deep water and eat little, but as the water warms they again begin to chase minnows and to capture crayfish.

It is recommended that a program for improving bass fishing in the streams of Ohio be built upon a policy of:

(1) Fostering research in order to discover new facts and principles pertaining to fish populations, their cycles of fluctuations, and factors influencing their welfare;

(2) Utilizing the facilities of the state fish farms as aquicultural experiment stations, to develop methods of practicing fish management in natural waters;

(3) Improving fish habitats in streams by (a) erosion control, and (b) small dams;

(4) Using the products of the state fish farms in a modified stocking program aiming to supplement habitat deficiencies;

(5) Establishing more fish sanctuaries to provide protection for breeding and feeding of bass and certain forage species;

(6) Establishing certain "test streams" for experimentation with reduced length limit on bass and permitting spring fishing.

R. L. C.

FISH PROPAGATION IN MOUNTAIN AREAS

By Dr. R. J. Gilmore, Colorado College

WORK ON FISH propagation in the regions of high altitude and limited rainfall is just beginning. In many respects the problems of mountain streams are peculiar, and stocking policies that bring results in other parts of the country fail utterly.

Many high altitude lakes are completely frozen over from late August to early July. The season of growth for aquatic plants is seldom longer than from June 15 to August 15. As a result of such conditions it is not uncommon to find fishes less than five inches long whose age is four or five years.

Absence of available minerals, especially calcium compounds which contribute to bone structure, is another cause of slowness of growth.

The relation of forage fishes to trout in high altitudes needs study. In one lake suckers and dace may thrive with trout while in others they may completely spoil the vegetation which is necessary for insect life. Some lakes containing suckers are clear, others muddy.

The short season retaining pond is a means of helping food conditions for young trout. Daphnia, Diaptomus and Gammarus usually flourish in ponds warmed to 60° - 70° in midday. To these are added midge larvae, caddice worms, may fly nymphs and other aquatic insects. Brook trout fry one inch long were raised to 4½ inches in 90 days on natural food raised in such a pond at an altitude of 10,00 feet. The introduction of the scud, Gammarus, has not been uniformly successful.

Low temperatures may be modified by small dams. Dams of 10 to 20 feet maximum height covering areas from one to twenty acres have proven valuable in fish propagation. Construction of such dams and their continued usefulness depends on control of soil erosion, caused largely by excessive grazing. Limited grazing and soil conservation are recommended.

In most mountain states recreational uses of water have no legal status. Reservoirs may develop a rich fish population only to be drained to complete dryness by the needs of farms. The fish situation would be helped if recreation were recognized as a third right in water.

R. L. C.

FOUNDERS OF FISH CULTURE

DWIGHT LYDELL, 1861 - 1927

By Dr. Jacob Reighard
University of Michigan

DWIGHT LYDELL was born on a farm in Chautauqua County, New York, on September 26, 1861, shortly after the outbreak of the Civil War. His father was William Lydell and his mother was born Emily Coe. While he was a child his father moved to a wilderness farm in Michigan, at a time when the trees of the primeval forest were still felled in windrows and burned to clear the land. Dwight worked on the farm until he was twenty-two and meantime finished his education in the local rural schools. Those

were the days when Dr. Chase's "Receipt Book" was kept in every farmhouse and consulted by the farmer for all sorts of things, from bronzing his gun-barrel or mending his harness to doctoring his horse, his family or himself. Roads were so bad and farms so far from town that the farmer had to be resourceful and self-independent, a jack-of-all-trades. The farm was a school in which men learned by doing. In this school young Lydell grew up and in it, no doubt, he gained that ready practical insight into the ways of doing things which was always one of his outstanding traits, for, with whatever tools and materials were at hand, he was ever able to do what had to be done. To paraphrase Huxley, he could "bore with a saw and saw with an auger".

And so, with little formal education, but with a world of practical resources, he was equipped to pass from the work of the farmer to that of the fish-culturist. The chance came in 1883 when he joined the staff of the Michigan Fish Commission's trout hatchery at Paris, no doubt as an apprentice. Here he learned the technique of the trout hatchery. During the summer he was usually one of a party sent out by the Michigan Fish Commission to examine the inland lakes of the state. During the first summer the party of four or five traveled by wagon across the southern tier of Michigan counties from west to east, then back westward across the next tier to the north, and so ever northward. It usually took a summer to traverse a single tier. It was the custom to camp for several days on some large lake of a group and using the camp as a base to examine that lake and several others of the group. Thus a week might be spent at one camp. Rough hydrographic maps were made of the selected lakes, bottom and surface temperatures were taken, nets were used to find what fish were present and a record was made of their stomach contents. During a part of the summer of 1891 I was with this party as it traversed the state from Grand Rapids westward. Besides the driver of the wagon, Uncle John, and the cook, there were four practical fish-culturists - men of little schooling who had gone from the farm or the small town into the hatcheries, to learn the trade. They were quite innocent of science, but had a first-hand knowledge of fish and a shrewd handiness that enabled them to do good work. Their findings, carefully recorded and still on file, were a valuable guide in the later planting of fish in these lakes. Here, as on the farm, Lydell was learning by doing.

While working at Paris in the winter and spring and examining inland lakes in the summer, Lydell went each fall to some one of the islands in the Detroit River to take whitefish eggs for the Michigan Fish Commission. Owing to failure of the fisheries elsewhere in the river, this work was finally restricted to Belle Isle. In 1901, it came under control of the United States Bureau of Fisheries and was continued by it until 1908, when further decline in the fishery led to abandonment of the Bell Isle work and closing of the Detroit hatchery. During the period 1901-1908, Lydell was in charge of the Bell Isle fishery for the United States Bureau of Fisheries. Here, in November, great seines were operated and the captured whitefish were held in pens until ripe. They were then stripped and the eggs transferred to the hatchery on Joseph Campeau Avenue in Detroit. The stripped fish were sold and many people came from Detroit to buy them for home use. In this work Lydell broadened and deepened his practical experience.

In 1894, the Michigan Fish Commission began the pond culture of blackbass at Cascade on the Thornapple River, and placed the work in Lydell's hands. After four years, i. e., in 1897, this work was transferred to Comstock Park, on Mill Creek, near Grand Rapids. There Lydell carried it on until his death in 1927. Including the years at Cascade he had thus devoted thirty-three years chiefly to study and experiment in the pond culture of the large and smallmouth black bass. That was really his life work, for which all that went before may be thought of as preparation.

So far, I have sketched Lydell's growth from farm worker to practical fish-culturist and then to independent and original student of the problems of pond culture of the black bass. Before going into the details of the black bass work I must deal with his contacts with the work of scientific men and with its effect on him. In the spring of 1890, I went to the mouth of the Kawkawlin River on Saginaw Bay to study the eggs of the walleyed pike. At that time, as now, most of the eggs placed in the hatcheries died before hatching and I hoped to find a means of increasing the percentage hatched. Lydell was among the spawn takers stationed at the mouth of the Kawkawlin, and there I had my first contact with him. I soon found that, unlike the other men, he had a keen native curiosity. He wanted to know what I was doing and why and he showed a ready understanding of it all, asked many questions and wanted to see and learn all he could. In the summer of 1892, Professor H. S. Jennings, now of Johns Hopkins University, was with the Michigan Fish Commission's field party examining inland lakes, and Lydell was a member of the crew. In the fall of 1892 I spent some time on Belle Isle in the Detroit River studying the eggs of the whitefish and found Lydell in charge of operations there. In the summer of 1894, I was at New Baltimore, on Lake St. Clair, in charge of a party making a biological study of the lake. Lydell was assigned to us as a man of all work. We had to rig up a laboratory in an old warehouse at the wharf and Lydell's resourcefulness was an enduring comfort to us. He served as plumber, carpenter, boatman and in many other capacities, and was always efficient. He seemed to have an inborn sense of how to do things that solved for him problems that might puzzle us, though we approached them with calculus and trigonometry. One day we had spread on the floor a costly piece of silk bolting-cloth and were trying to make a pattern to be used in converting the flat cloth into a conical plankton net. We had calculated angles and chords and radii by the book, but we had not succeeded in getting a pattern that rolled into a perfect cone. Lydell was looking on and finally said, "Let me see if I can't do that". Then, with a piece of string and a lead pencil, he marked out a pattern which proved, when rolled up, to make a perfect cone of the size and form that we wanted. Parenthetically, I may add that at Comstock Park, he built bridges of concrete and did other engineering work by similar direct methods and without seeking professional help. In the summer of 1894, Lydell was an assistant at Charlevoix where a party under the direction of Professor H. B. Ward, now of the University of Illinois, was making a biological survey of Lake Michigan in that region.

In the spring of 1903, and again in the spring and summer of 1904, I was at Comstock Park to study the black bass. Troubles were many, and it was hoped that some of them might be overcome by scientific work. I lived with Lydell's family

during my stay, and came into intimate daily contact with him for several months. He had then been working at the pond culture of bass for nine years and had solved some of its problems, but there were more problems still to be solved and we spent long days discussing them. So it happened that in the course of thirteen years Lydell had been in close contact with scientific men on six occasions and had had opportunity to observe their work, to help them with it and to discuss it with them. He had learned much of their technical methods and he seemed to me to have taken on their ways of thinking and of working. He came thus to his work on black bass with the practical training of the farmer and the fish-culturist and with no little knowledge of scientific ways of doing and thinking.

At Comstock Park in 1897, he found Mill Creek, a stream that traversed several miles of open cultivated land above the hatchery location. It was subject, as he was to learn, to great fluctuations of discharge, even to the extent of floods. Owing to its shallowness and exposure to the sun, it was subject to great fluctuations of temperature from day to night and from week to week. Beside it he found a cool spring and a tract of low flat land in which ponds could be easily excavated. Here he set to work to build his bass hatchery, to construct ponds, and to put brood fish into them.

At Cascade he had watched the smallmouth bass build their nests in the Thornapple and learned to tell the sexes apart. He had learned that the males were the builders of the nests and the guarders of the eggs and young fish, and he was the first to make it known to others. He had learned that the breeding males fought one another and that they sometimes destroyed the nests of their rivals. He had tried artificial fertilization and found it impracticable, so that he now knew that pond culture was the only means left. When he began the cultivation of bass in ponds he learned much more. With fluctuations in the temperature of the stream, the pond temperatures often went below 50° Fahrenheit and then the males deserted their nests and the eggs died. When the stream became turbid, silt settled over the eggs in the nests so rapidly that the guarding males could not keep them free of it. The eggs were smothered and the fish deserted the nests. When the fish were put into breeding ponds, there was much fighting among the males, and many nests were destroyed. He must find ways of overcoming these difficulties, and he did, but they remained real difficulties until 1905.

How he met his troubles is told in the papers that follow. To keep the males from fighting he invented nest boxes and so placed them in the ponds that the fish could not see one another while on the nests. To accommodate the nest boxes, he built ponds with shallow water about the shores, in imitation of a natural lake. To further reduce fighting, he sorted the fish before placing them in the breeding ponds in such a way that the males in each pond were of the same size and were fewer than the females. Thus each male found a mate without needing to fight for it and as each male could pick a fight only with another of his own size (there were no little fellows to pick on), fighting became rare.

But these troubles being met, there were others. The cold and often roily water had to be dealt with. This was accomplished by placing the breeders in small retaining ponds of cold water and without suitable bottom for spawning and leaving them there until the water in the breeding ponds was warm and clear and likely to stay so. In the retaining ponds, the fish did not spawn, but when transferred to the breeding ponds they spawned at once and were too busy to fight. It was found that stock bass must get enough of the right kind of food or they do not produce viable eggs. Out of this need grew the use of clam meal, made from the dried bodies of fresh-water mussels thrown away by the pearl fishermen. Blood coagulated with rennet also came into use. The fingerlings also must have suitable food, and this led to the cultivation of Daphnia and other fresh-water food forms. To rear these forms Lydell learned to drain his ponds in the fall and let them freeze and to fertilize them with clam meal and other fertilizers.

Every failure was an incentive to fresh effort and much of each winter was given to thinking out ways of meeting difficulties. This continued until about 1925. By then he seemed to have gained such control of the pond culture of black bass that he could formulate the necessary procedure with all needed detail. Even before the date named, he had begun the rearing of perch and bluegills in his ponds. He now found that the same pond might be used for perch in the spring and for bluegills a little later. The output of the pond was thus doubled. He succeeded also in raising fingerling rainbow trout to a length of three and a half inches in ponds that had produced fingerling bass earlier in the season. Again the production of the pond was doubled.

It had been one of the cardinal tenets of fish culture that brook trout would not thrive in water of a temperature above fifty degrees; but, at Comstock Park, Lydell reared healthy brook trout to a length of four to six inches in five months, in ponds in which the water temperature varied from 46° F. to 75° F.

Thus for thirty-three years, Lydell's chief occupation was the pond culture of black bass. That was his life work, but as preparation for it, his earlier experience on the farm and in the various sorts of practical fish culture are invaluable. Endless patience, great skill, devotion and ingenuity went into this work, and the published results are a lasting monument to his memory. But back of all training, all experience, were the innate qualities of the man. From natural aptitude and from contact with scientific men, he had, it seemed to me, come to have the outlook on life of the best of our scientific men, and he had their ways of experimenting and thinking. He gave little thought to advancing himself, but devoted himself to his work for its own sake, after the manner of the best type of scientific investigator. Under other circumstances he might have become one of our great leaders in science. That he was besides that a kindly, lovable, generous man, always sincere and upright - a gentleman always, as many friends can testify.

From 1915 to 1925, he was Assistant Superintendent of Hatcheries for the Michigan Fish Commission, a position which he retained when the Commission was absorbed by the present Conservation Commission. He was a member of the American Fisheries

Society and was listened to with great attention. He was a member also, of the Marion Fish and Game Association, Indianapolis, Indiana; of the West Michigan Fish and Game Association of Grand Rapids; and of the Izaak Walton League, the Grand Rapids Chapter of which bears his name.

Thrice married, he is survived by his wife, Mrs. Jennie Noel Lydell, by her two sons, by a daughter of his first marriage, a sister and two brothers. He died February 8, 1927, and is buried in Greenwood Cemetery, Grand Rapids.

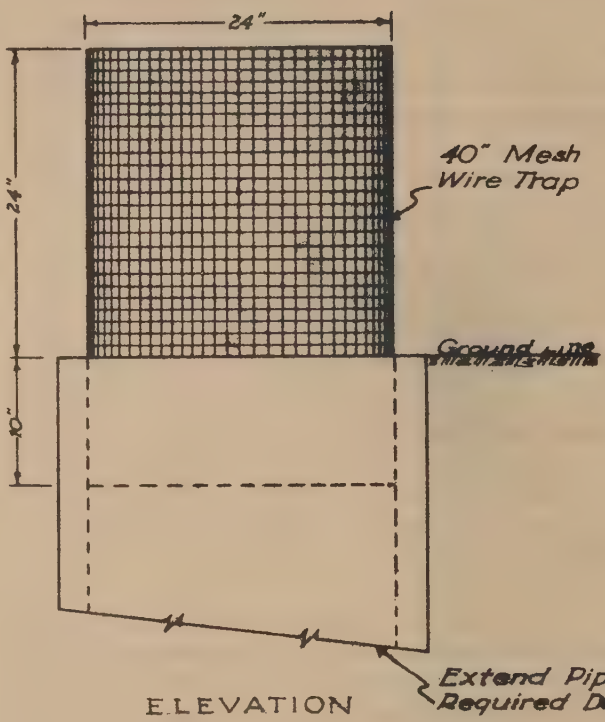
COMMENTS FROM OUR READERS

A BASS FRY TRAP

Editor, THE PROGRESSIVE FISH CULTURIST:

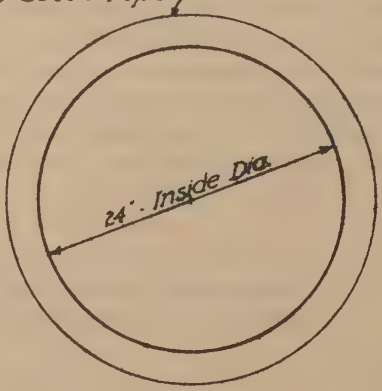
Attached you will find a blue-print showing the type of bass fry trap that I am using very successfully. This trap is not new, but I think the concrete or terra-cotta nest is. We place a concrete or terracotta pipe with a 10-inch nipple, putting the nipple into the ground up to the bell of the pipe, filling this partly with dirt and rock, and lastly, with sand and gravel, filling it up to the level of the bottom of the bell. After this gets wet it will settle down a little below the level of the bottom of the bell. We usually mound this and gravel in a pyramid in the middle of the nest so that the Bass will have a little work to do in making the nest. After the eggs are laid in this nest we simply drop a cylindrical screen into the bell of this pipe and take the fry out of the screen trap from the top. This, I think, is very much better than the old box trap. It is permanent and can be made very economically by purchasing the proper size form. This can be 24, 30, or 36 inches in diameter - to suit the hatchery superintendent. He can make such a trap during spare time at the hatchery. He will have a permanent bass nest that doesn't have to be made over every year.

J. E. Bost,
Department of Game and Fish,
Columbia, South Carolina.



ELEVATION

24" Concrete or
Terra Cotta Pipe



PLAN

BASS TRAP

Used by Dr. J.E. Bost
Director of Fish Culture
S.C. Fish & Game Dept.

#6777

BEHAVIOR OF HATCHERY TROUT IN STREAMS

Editor, THE PROGRESSIVE FISH CULTURIST:

Dr. J. O. Snyder's letter referring to my letter in the Salmon and Trout Magazine seems to raise the question in his mind as to whether these statements have any further basis than my assertion. He would like to see this question officially investigated and reported on. Nothing could be more desirable and I heartily approve of this suggestion which I know will conclusively prove my statements. Few fish culturists in this country, up to the present time, have made any actual checks on the results of stocking of various kinds. They have not had sufficient opportunity to do so as yet. Work of this kind is under way now, I am glad to say, in several places.

My statement was the result of over fifty years of observations on trout stocking where the results could be really appraised and were not made from ideas only but from actual work. I have also talked with many of the best men in this country on this subject and every one who has had any actual experience in checking stocking results has agreed with my views. I think I have enough evidence to back up the statements made in the Salmon and Trout Magazine. I would sum up the results I have found in stocking so far as follows:

Stocking with early fry which have not been fed will grow all the trout in a stream which this stream can product under natural conditions. No other kind of stocking will make any more fish. Fed hatchery fry have not shown as good results as unfed fry in my experience, and I will give reasons for this later.

Fingerling stocking will not produce as many trout in a stream as fry stocking and in most cases very many less adult trout. There is no advantage in stocking fingerlings over fry; on the contrary, fingerlings nearly always grow less fish and cost much more to put out. In many cases which I have observed, little or no results are obtained from fingerling stocking. Reason for this will also be given.

Adult catchable sized fish stocked in streams produce good fishing if these fish are stocked during or just previous to the season, and they are caught out during the season. If they winter over, the losses are large and the remaining fish are generally poor the succeeding spring. Large fish stocked several months before the fishing season lose weight, generally, and make poor game for anglers in most streams.

It was the knowledge of these facts which started me on the study of trout diets and organs to see if the explanation was, as I had supposed, that trout must get their stream education early or not at all, or whether there was some other reason which would account for what I had observed.

A careful study of the livers of wild and hatchery trout revealed the fact that the livers of these two kinds of fish were rarely similar in composition chemically or of the same microscopic structure. Practically all the hatchery trout I have examined from a dozen hatcheries have had livers which showed more or less fatty degeneration. In many cases a very large proportion of the liver cells were so enlarged as to be useless. As trout don't die until perhaps 90 percent of their liver cells are destroyed, we do not notice any difference in the fish except that they are less resistant to various trout diseases. In other words, the loss of a large proportion of the liver cells for the purposes of their regular functions reduces the vitality of the fish.

The causes of this trouble have so far been found to be, eating too much food for the weight of the fish under the conditions he lives in; eating food too high in cholesterol which will accumulate in the livers of trout as in the livers of other animals; a deficiency of vitamin C in the diet. It has been found that trout have a high requirement for vitamin C and deficiency leads to symptoms of scurvy which are very similar in trout and guinea pigs, as I have found in my studies. Vitamin C deficiency will cause fatty livers in trout in a few weeks.

Beef or sheep liver would be an ideal food for trout if it were not too high in fats and cholesterol. Liver has a high percentage of vitamin C when fresh, but freezing or storage causes a rapid reduction in the vitamin content. I have found three samples in hatcheries so far in which the vitamin had been reduced from 1.5 milligrams per gram to .10 milligrams per gram. The general run of hatchery livers tested run from .60 milligrams to .80 milligrams. From this it will be seen that hatchery fish are liable to a shortage of vitamin C in their food whereas wild fish have an ample supply in all the food they get.

A more complete study of the actual vitamin in the foods fed to hatchery trout, and a better knowledge of their requirements, will show the way to grow hatchery trout with livers as good as those of wild trout. When this is done, and we have hatchery trout similar to wild trout in all their organs and tissues, I believe that they will do as well as wild trout in the streams.

Unfortunately, fatty livers repair very slowly when trout are placed on a suitable diet. In six months the repair is very slight, and Dr. Gaschoff of Munich maintains that fatty livers never entirely recover. I am inclined to believe that he is right if such fish are fed any ordinary diets, but recently I have been feeding diets very high in vitamin C and have noted signs of very rapid repair. If this can be accomplished practically, we can perhaps undo some of the damage which has been done by improper feeding.

Fry fed as they are usually fed in hatcheries, on liver four or five times a day, develop fatty livers almost at once, and are not normal fish after the first month of feeding. Fingerlings are liable to be in even worse condition, and this is the reason why such fish do not do as well as they should when planted in streams.

At present, our hatchery trout behave as stated when stocked, but there is every reason to hope that when we learn to grow really normal trout in every way, that they will do as well as wild trout in streams after they have had time to learn to avoid destruction by vermin, which wild trout learn very early. I have every reason to believe that complete study of these problems will very greatly increase the efficiency of all stocking of trout and make it entirely satisfactory.

Edward R. Hewitt
127 East 21st Street
New York City.

WHAT BECOMES OF FISH AFTER PLANTING?

BIRDS EAT SOME.

Editor, THE PROGRESSIVE FISH CULTURIST:

I was very much interested in W. M. Keil's article entitled, "Better Stocking Methods", also in Fred Richan's, "What Becomes of the Fish Planted". Both name factors important in better fish cultural methods, but there are several others that deserve consideration along with them. I have in mind principally the natural enemies of fish after they are planted as well as those in the hatchery nursery.

It is true if the fish are not properly planted that much of the work for the entire season has been wasted. Only men capable and dependable should be trusted with the distribution work. More study and preparation should be made previous to planting. Plans should be made with the local sportsmen to help with the planting, having the locations for planting picked out before the fish arrive. If this isn't done right or the right men contacted the messenger will find that the enthusiasm has died and he will have the fish to plant by himself or hunt help after arriving.

Anyone that has done distribution work knows all about the kind of help one usually gets. I have had to hire guides and help after arriving at the town designated by the instructions for the delivery of the fish. This proves that at present the job of planting fish is mostly up to the fish culturist. Every fish culturist and "Fish Planter" knows of instances where the fish arrived belly up as alluded to by "Just a Fish Planter" in the January issue of THE PROGRESSIVE FISH CULTURIST. But I believe these incidents are rare as fish have been hauled hundreds of miles in Fearnow pails by truck and placed in holding tanks where they were observed for the effect of the trip and the loss was very small.

It really is no wonder that sportsmen, Forest Service men, etc., are asking what becomes of the fish planted. Why does fishing get worse instead of better in most cases? Is it any wonder after reading about all the millions of fish planted that many remarks are heard about paper fish? After all the best argument for suc-

cess or failure is the size of the fisherman's catch. We agree with Richan that a fish culturist's job does not end with the planting of the fish.

We have the answer to "What Becomes of the Fish Planted", in this part of the country. I refer to the great army of natural enemies of the fish - the merganser, the herons, bitterns, kingfishers, snakes, ospreys, turtles, mink, skunks, and many others, that feed more or less on fish. Heading the list in this section is the merganser followed by the heron. We believe that these enemies are much more serious than many suspect. We have selected several hundred of the largest bass fingerlings to hold over for future brood stock each of the two seasons we have been here and the mergansers have completely cleaned us out each time. It only took them about a month to do it.

What happens to us probably is heppening to every lake and stream in this country. Lake Van, a club-owned lake adjoins us. There is always a good hatch of fish, especially of black bass each season. They are in evidence well into December, in fact they are so thick that one cannot fish for large fish late in the season. They make a good growth, many being eight inches long and very thick. We have fished the lake for brood stock in the spring and never have seen any of this size. I have watched the mergansers work, through the transit of a surveying instrument, on this lake. There is no doubt as to what becomes of the fish. Their work is not always restricted to small fish, for we have known them to kill 16-inch fish. They don't eat the large fish. Their work and presence is always indicated here by the gulls following them to pick up the dead and cripples neglected by the mergansers in their haste to kill. Gulls themselves take some live fish. Herons destroy large numbers of fish as they are with us the year round. I have examined the stomach contents of scores of mergansers and herons and I would say 95 percent contained game fish. I once counted 162 two-inch trout in the stomach of a great blue heron, and 85 trout of the same size in the stomach of one night heron.

Of course nursery ponds can be fenced, although at great expense, but what about lakes like Lake Van and hundreds of others? Why not do the obvious thing, destroy these natural enemies? Why does not the true sportsman demand that these birds be classed as vermin? They are far more harmful than lots of the so-called vermin, with absolutely no value to give a slight recompense for their damage. While the coon, mink, and skunks are fish eaters they do have some value as fur bearers. The skunk is known to be very fond of turtle eggs and turtles are very bad for fish ponds. I have heard that herons destroy snakes, but of the scores examined, the writer has yet to find one in the stomach of a heron.

It is a known fact that some forms of vermin prey on other forms of vermin and to destroy all enemies of fish might disturb the balance of nature and more harm than good would be done. But something should be done along these lines. Men qualified should be detailed to make investigations to ascertain what can be done safely. We have noticed that in lakes with abundant vegetation the birds eat less fish. Also in the northern part of this state where the lakes are frozen several months of the year the fishing is better. Just planting fish is not getting us anywhere

and something must be done. Personally I would like to see the restrictions taken off for killing mergansers, herons, bitterns, kingfishers and ospreys, and a bounty offered. I know this will meet with great protest from bird lovers. But are we to continue to plant fish to feed these birds? The coyote has some value as he lives mostly on other forms of vermin, but you hear no protest when the Government places a bounty on him. We would class these birds with the coyote, mountain lion, and horse thieves.

Clarence E. Cozort,
Fish Culturist,
Dexter, New Mexico.

BASS, CRAPPIES, AND CARP EAT OTHERS.

U. S. Fisheries Station
Spearfish, South Dakota

Editor, Progressive Fish Culturist
Washington, D. C.

Dear Sir:

In a recent issue of "The Progressive Fish Culturist" Mr. Fred Richan offered the query, "What Happens to fish after they are planted?" The question is timely, apt, and pertinent and ought to be answered. Mr. Richan offered no answer to his query. Nor has anyone - nor can anyone - providing the subject in question refers to and pertains to each fish of the seven billion odd produced annually by the Bureau of Fisheries.

There is irrefragable and indisputable proof that some of these fish survive to reach the desired end, whether that be on a slab at the fish market or in some happy angler's creel. Equally positive evidence indicates that some do not survive to serve the purpose for which they were obviously intended. Therefore, since we are certain that all fish produced by our hatcheries neither survive nor perish, let us consider the mythical case outlined below. It is believed that most fish culturists will be able to alter names and places and fit the case to one or more actual occurrences.

On a certain day in October 20 pails of 4-inch rainbow trout were loaded and transferred from a government fish hatchery to the waiting fish car and promptly and completely forgotten by the hatchery crew. Their responsibility was finished. For two days and one night the fish car crew cared for and tended the fish to the full extent of their ability. On the afternoon of the second day the car stopped briefly at Two Skunk, Wyotana, and 20 pails of trout delivered to applicant Billy Hill. Mr. Hill loaded the pails onto an ancient conveyance that had once been an automobile. Now it happened that the fish were to be deposited in Wahoo Lake as per the applica-

tion, but as Billy bounced over the mountain road he reflected that if he proceeded to Wahoo Lake he probably would be late for supper that evening, and after all, what difference did it make anyhow whether the fish were planted in Wahoo Lake or Yahoo Lake, which was so much easier of access? They were his fish, weren't they? He signed for them, didn't he? Using his truck, wasn't he; and doing all the work? Who would know the difference anyway? Besides Billy Hill would just as soon fish in Yahoo Lake as Wahoo Lake. So 20 pails of 4-inch rainbow trout were, on this certain warm October afternoon, planted in Yahoo Lake which already contained large, if indeterminate, numbers of bass, crappie, carp, bream, suckers, catfish, and yellow perch.

What happened to THEM after they were planted?

Very truly yours,

RALPH W. YOUNG
Apprentice Fish Culturist.

PREVENTING DEPREDATIONS OF FISH-EATING BIRDS

Editor, THE PROGRESSIVE FISH CULTURIST:

Replying to your letter of December 5 wherein you ask for a description of methods employed by this Department in curbing depredations of fish-eating birds at our hatchery, will state that we have thus far employed no artificial devices. The greatest loss which we sustained at our fish rearing stations is that attributable to grackles at our trout hatchery at Rapid City, and we believe that this may be overcome by redesigning our ponds. Our nursery ponds as originally designed were grass sloped to the water's edge, which made an ideal set-up for grackles in that they would sit at the water's edge and when advanced trout fry or small fingerlings came within reach they would pick them up and carry them to their nests. This is being overcome by reconstructing our ponds, using ledge rock masonry in a perpendicular wall extending 12 inches above the maximum water level. This would not be effective in reducing depredations by herons or kingfishers, but we have never had any difficulty with the former, and kingfishers are not sufficiently numerous in that locality to constitute a menace.

Our facilities for the propagation of bass, bluegill and crappies are not extensive. We have a number of small stations operated by game wardens who reside at the hatcheries, and through personal vigilance we have thus far been able to control fish predators without installing artificial devices.

O. H. Johnson, Director,
Department of Game and Fish,
Pierre, Scuth Dakota.

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